



WHAT IS CLAIMED IS:

1. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure, which comprises a step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate and a step of oxidizing or nitriding the formed silicon film with ions and radicals formed from an oxidizing gas or a nitriding gas.

2. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure, wherein a step comprising of the first step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate and the sequential second step of oxidizing or nitriding the formed silicon film with ions and radicals formed from an oxidizing gas or a nitriding gas is conducted plural times.

3. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 1, wherein the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is carried out by using a thermal catalysis reaction in a gas system containing at least a silicon hydride gas and a hydrogen gas.

4. A method of forming an oxygen- or nitrogen-terminated

silicon nanocrystalline structure according to claim 2, wherein the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is carried out by using a thermal catalysis reaction in a gas system containing at least a silicon hydride gas and a hydrogen gas.

5. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 1, wherein the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is carried out by setting the substrate at a predetermined temperature in a plasma treatment chamber and then applying a high-frequency electric field while regulating the inside of the plasma treatment chamber at a reduced pressure containing at least a silicon hydride gas and a hydrogen gas.

6. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 2, wherein the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is carried out by setting the substrate at a predetermined temperature in a plasma treatment chamber and then applying a high-frequency electric field while regulating the inside of the plasma treatment chamber at a reduced pressure containing at least a silicon hydride gas and a hydrogen gas.

7. A method of forming an oxygen- or nitrogen-terminated

silicon nanocrystalline structure according to claim 5, wherein the frequency of the high-frequency electric field applied in the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is a VHF-range high frequency having a higher frequency than 60 MHz.

8. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 6, wherein the frequency of the high-frequency electric field applied in the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate is a VHF-range high frequency having a higher frequency than 60 MHz.

9. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 1, wherein the step of oxidizing or nitriding the silicon film formed on a substrate with ions and radicals formed from an oxidizing gas or a nitriding gas is plasma oxidizing treatment or plasma nitriding treatment of the silicon film by arranging the substrate having the silicon film formed thereon in a plasma treatment chamber, replacing the atmosphere in the plasma treatment chamber by an oxidizing or nitriding gas atmosphere and then applying a high-frequency electric field.

10. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 2, wherein

the step of oxidizing or nitriding the silicon film formed on a substrate with ions and radicals formed from an oxidizing gas or a nitriding gas is plasma oxidizing treatment or plasma nitriding treatment of the silicon film by arranging the substrate having the silicon film formed thereon in a plasma treatment chamber, replacing the atmosphere in the plasma treatment chamber by an oxidizing or nitriding gas atmosphere and then applying a high-frequency electric field.

11. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 9, wherein the plasma oxidizing treatment or plasma nitriding treatment is composed of plasma oxidizing treatment or plasma nitriding treatment in an oxidizing or nitriding gas atmosphere, subsequent etching treatment, with an HF-based gas, of the surface of fine silicon crystals in the silicon film formed on the substrate, or plasma etching treatment of the surface of fine silicon crystals in the silicon film formed on the substrate in a molecular gas system containing fluorine, and subsequent plasma oxidizing treatment or plasma nitriding treatment in an oxidizing or nitriding gas atmosphere.

12. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 10, wherein the plasma oxidizing treatment or plasma nitriding treatment is composed of plasma oxidizing treatment or plasma nitriding treatment in an oxidizing or nitriding gas atmosphere, subsequent

etching treatment, with an HF-based gas, of the surface of fine silicon crystals in the silicon film formed on the substrate, or plasma etching treatment of the surface of fine silicon crystals in the silicon film formed on the substrate in a molecular gas system containing fluorine, and subsequent plasma oxidizing treatment or plasma nitriding treatment in an oxidizing or nitriding gas atmosphere.

13. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 9, wherein the high frequency of the high-frequency electric field applied in the plasma oxidizing treatment or plasma nitriding treatment is a high frequency having an LF-range high frequency applied to a VHF-range high frequency having a higher frequency than 60 MHz.

14. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 10, wherein the high frequency of the high-frequency electric field applied in the plasma oxidizing treatment or plasma nitriding treatment is a high frequency having an LF-range high frequency applied to a VHF-range high frequency having a higher frequency than 60 MHz.

15. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 11, wherein the high frequency of the high-frequency electric field applied in the plasma oxidizing treatment or plasma nitriding treatment

is a high frequency having an LF-range high frequency applied to a VHF-range high frequency having a higher frequency than 60 MHz.

16. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 12, wherein the high frequency of the high-frequency electric field applied in the plasma oxidizing treatment or plasma nitriding treatment is a high frequency having an LF-range high frequency applied to a VHF-range high frequency having a higher frequency than 60 MHz.

17. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 1, wherein in the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate, the thickness of the silicon film is from 1 to 10 nm.

18. A method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure according to claim 2, wherein in the step of forming a silicon film of nanometer scale thickness composed of fine silicon crystals and amorphous silicon on a substrate, the thickness of the silicon film is from 1 to 10 nm.

19. A silicon nanocrystalline structure formed by the method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure as described in claim 1.

20. A silicon nanocrystalline structure formed by the method of forming an oxygen- or nitrogen-terminated silicon nanocrystalline structure as described in claim 2.